When Nash met Markov

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Summary

In this thesis we focus on two problems at the intersection of mathematics and theoretical computer science: the inefficiency and computation of Nash equilibria in congestion games and the uniform generation of graphs with a given degree sequence using simple Markov Chain Monte Carlo methods.

We study congestion game models that can be used to analyze problems such as traffic congestion and internet routing from a theoretical point of view. We are interested in so-called Nash equilibria of these games. A Nash equilibrium is in some sense a 'stable' outcome of a game, meaning that no player of the game has an incentive to act differently.

We also study the *switch* algorithm for the uniform generation of graphs with a given degree sequence. The switch algorithm is a very simple Markov Chain Monte Carlo approach that proceeds by repeatedly selecting two edges of the current graph and switching them if possible, while preserving the degree sequence. The main question of interest here is how many switches are needed before the output is close to being a uniform random sample from the set of all graphs with the given degree sequence.